Eyenal Manual

(Windows)

for use with ASL Series 5000

Manual Version 1.3

Table of Contents

1. INTRODUCTION

1.1 File Naming Conventions

2. VIEW RAW DATA FILE

3. CALCULATE FIXATIONS

3.1 Purpose and Application

3.2 Making a Fixation File

3.2.1 Start-Stop Criteria

3.2.2 Fixation Criteria

3.2.2.1 Brief Description of Fixation Algorithm

3.2.2.2 Fixation Criteria Menu Options

3.2.2.3 Fixation Algorithm Criteria Description

3.2.3 Visual Angle Computation

3.2.4 Sample Calculations of Eye Tracker Units per Degree Visual Angle

3.2.5 Detailed description of Fixation Algorithm

4. DEFINE AREAS OF INTEREST (AOIs)

4.1Purpose and Application

4.2 Making an AOI File

4.3 Editing an AOI File

5. FIXATION SEQUENCE ANALYSIS (AREA OF INTEREST STATISTICS)

5.1 Purpose and Application

5.2 Making an Fseq File

5.3 Viewing Fseq file output

5.3.1 AOI Summary

5.3.2 Transition Table

5.3.3 Conditional Probability table

5.3.4 Joint probability table

6. CALCULATE DWELL STATISTICS

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6.1 Purpose and Application

6.2 Making a Dwell file

6.3 Dwell Sequence List

6.3.1 Dwell Sequence Summary

6.4 Dwell Transition Table

6.4.1 Dwell Conditional Probability Table

6.4.2 Dwell Joint Probability Table

6.4.3 Dwell Histograms

7. CALCULATE PUPIL STATISTICS

7.1Purpose and Application

7.2 Making a "pda" file

7.3 Pupil Diameter Sequence List

7.3.1 Pupil Diameter Summary List

8. BATCH CAPABILITY

8.1 Purpose and Application

8.2 Using the Batch Function

8.2.1 Batch Fixation Files

8.2.2 Batch Fixation Sequence Files

8.2.3 Batch Dwell Files

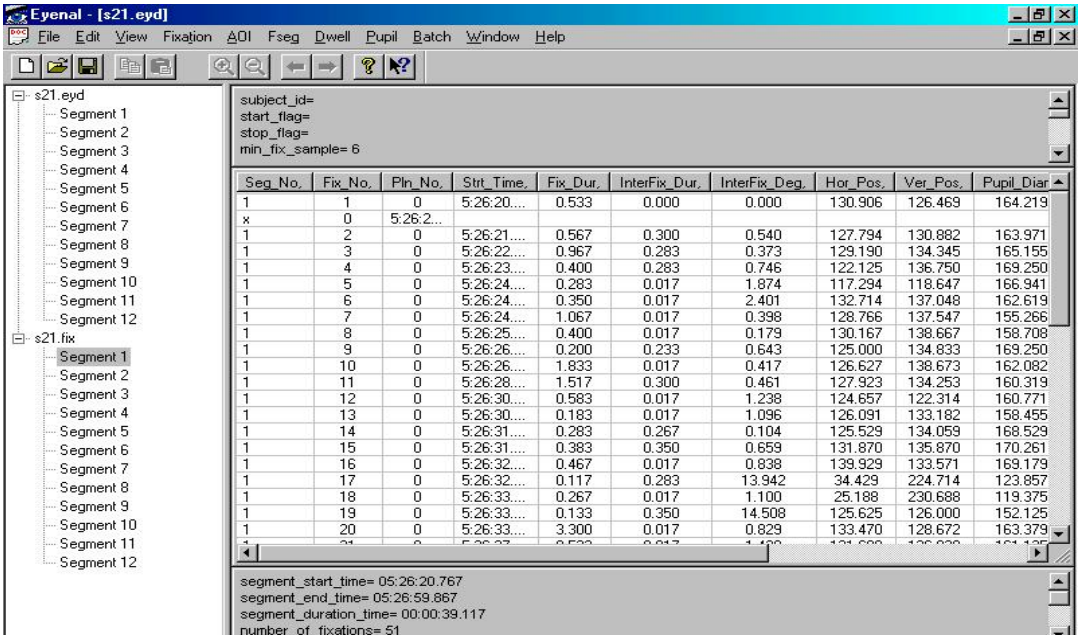
Table of Figures

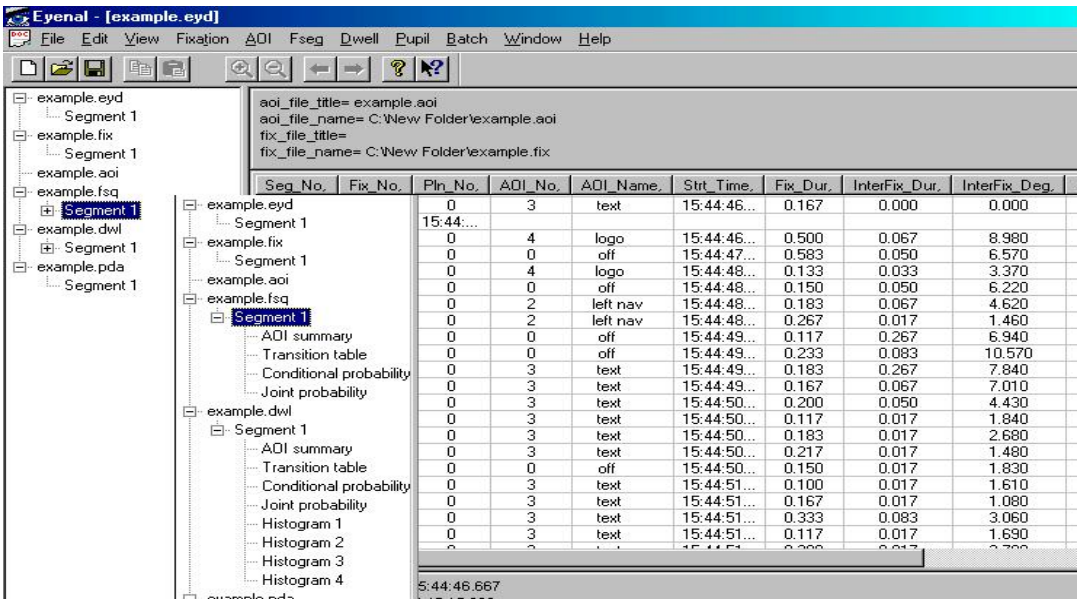
Figure 1. Sample Eyedat file for model 504 with MHT Option ..... pg 8
Figure 2 Sample EYEHEAD data file 11
Figure 3 Fixation Properties (General) pop up menu 12
Figure4 Start-Stop criteria menu 13
Figure 5.Fixation Properties (CRITERIA) menu 14
Figure 6. Fixation Algorithm Criteria (Criteria) menu 17
Figure 7 AOI Properties menu 20
Figure 8 Sample AOI File 21
Figure 9 Fixation Sequence Properties pop up menu 23
Figure 10 Sample Fixation Sequience List 24
Figure 11 Sample Fixation Sequence Summary 25
Figure 12Sample Fseq Summary Table (AOI Summary) 26
Figure 13 Sample Fseq Trabsition Table 26
Figure 14 Sample Fseq Conditional Probability Table 27
Figure 15Sample Fseq Joint Probability Table 28
Figure 16 Sample Dwell Properties pop up menu 29
Figure 17 Sample Dwell Sequence List 30
Figure 18 Sample Dwell Sequence Summary 31
Figure 19 Sample Dwell Histogram data 32
Figure 20 Pupil Diameter Analysis pop up menu 33
Figure 21 Sample **"pda"** file (Pupil Diameter Sequence List and Summary) 35
Figure 22 Batch Fixation File pop up menu 36

1. INTRODUCTION

EYENAL is an "off-line" data analysis program for processing eye movement and pupil diameter information recorded on EYEDAT and EYEHEAD data files. **EYENAL** identifies eye fixations, matches fixations with designated areas of interest on the scene, and calculates related scan pattern statistics. Subsequent statistical data is saved in Text file formats suitable for further processing with other data analysis or spreadsheet programs. Eyenal will also automatically export any of the original or analyzed data to Excel.

Eyenal will list all files currently open files on the left side of the program window in a file tree. To look at a file or any selected part of a given file left click on the desired segment and or left click the + sign next to a segment number to extend the file tree.





1.1 File Naming Conventions

Some ASL analysis program features recognize certain file name extensions for performing certain tasks. The following convention is used by ASL software.

ASL's EYENAL FILE NAMING CONVENTIONS

DESCRIPTION	FILE TYPE	FILE EXTENSION
Eye data recorded by series 5000 EyeTrackers, models 1050 Pupillometers, and 210 DARS programs.	EYEDAT	.EYD
Integrated EYEHEAD position data recorded by an Eye Tracker with a MHT(Magnetic Head Tracker) and EYEHEAD™ Integration software.	EYEHEAD	.EHD
Files created by EYENAL AOI specifying rectangular areas of interest on the viewed scene.	AREAS	.AOI
Files created by EYENAL FIX containing lists of eye point of gaze, fixations, and inter-fixation activity.	FIXATION	.FIX
Files created by EYENAL FSQ. matching Fixation data files created with FIX to AOI files created by AOI showing how a subject viewed various scene elements	FIX SEQUENCE	.FSQ
File created by EYENAL Pupil Diameter Analysis program that calculates various Pupil diameter statistics for select portions of EYEDAT data.	PUPIL	.PDA

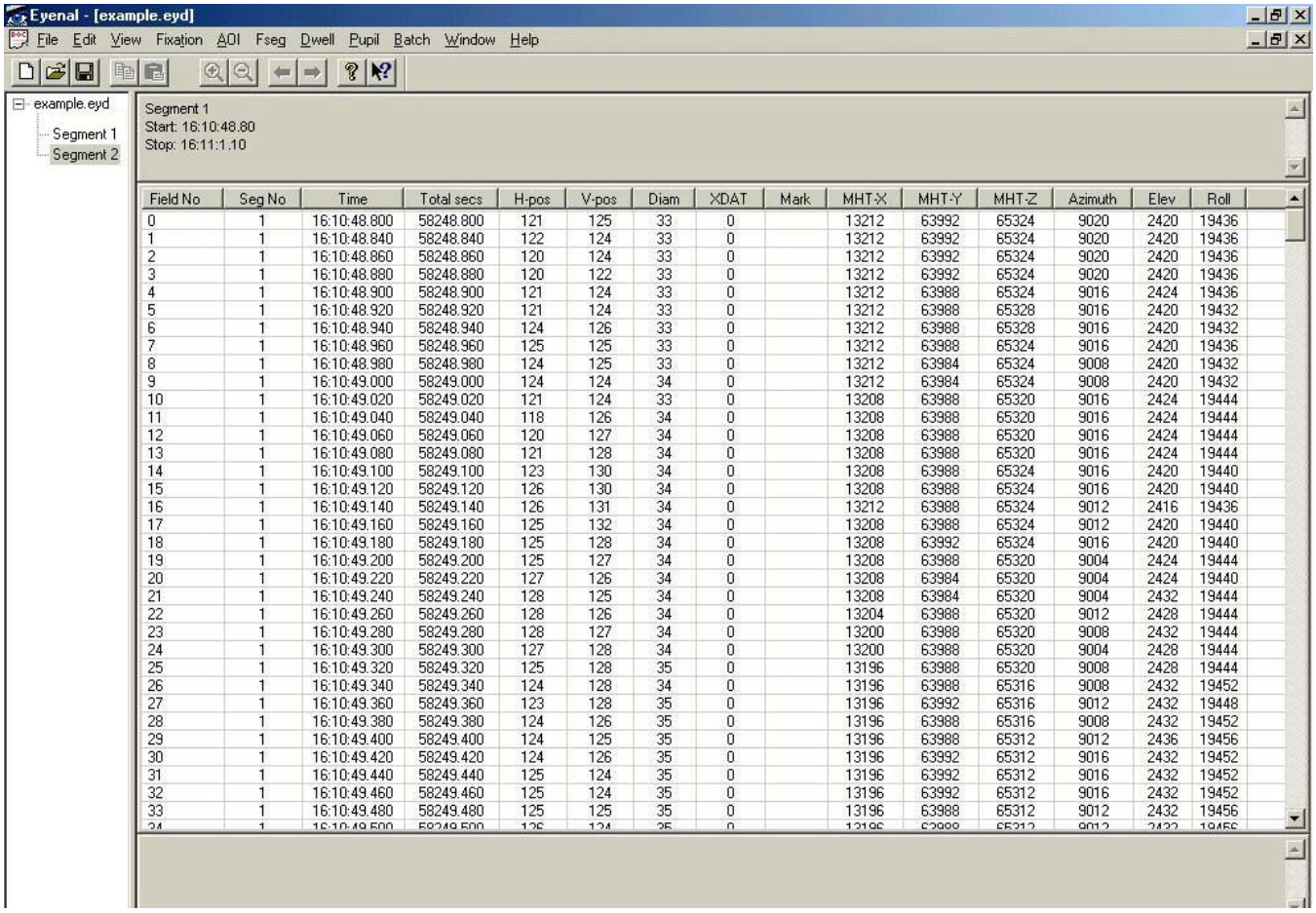
Data plotting files created by the EYENAL FIX function to facilitate making plots of fixation position versus time within a statistical program such as EXCEL.	PLT	
Files created by CONVERT function to convert binary EYEDAT or EYEHEAD files to an ASCII format suitable for input into other programs such as Excel.	CONVERT	.ASC

.

2. View Raw Data Files

To View an EYEDAT or EYEHEAD data file:

1. select "Open" from the File Menu
2. Browse to the desired EYEDAT or EYEHEAD file and select "Open" in the browser window.



Field No	Seg No	Time	Total secs	H-pos	V-pos	Diam	XDAT	Mark	MHT-X	MHT-Y	MHT-Z	Azimuth	Elev	Roll
0	1	16:10:48.800	58248.800	121	125	33	0		13212	63992	65324	9020	2420	19436
1	1	16:10:48.840	58248.840	122	124	33	0		13212	63992	65324	9020	2420	19436
2	1	16:10:48.860	58248.860	120	124	33	0		13212	63992	65324	9020	2420	19436
3	1	16:10:48.880	58248.880	120	122	33	0		13212	63992	65324	9020	2420	19436
4	1	16:10:48.900	58248.900	121	124	33	0		13212	63988	65324	9016	2424	19436
5	1	16:10:48.920	58248.920	121	124	33	0		13212	63988	65328	9016	2420	19432
6	1	16:10:48.940	58248.940	124	126	33	0		13212	63988	65328	9016	2420	19432
7	1	16:10:48.960	58248.960	125	125	33	0		13212	63988	65324	9016	2420	19436
8	1	16:10:48.980	58248.980	124	125	33	0		13212	63984	65324	9008	2420	19432
9	1	16:10:49.000	58249.000	124	124	34	0		13212	63984	65324	9008	2420	19432
10	1	16:10:49.020	58249.020	121	124	33	0		13208	63988	65320	9016	2424	19444
11	1	16:10:49.040	58249.040	118	126	34	0		13208	63988	65320	9016	2424	19444
12	1	16:10:49.060	58249.060	120	127	34	0		13208	63988	65320	9016	2424	19444
13	1	16:10:49.080	58249.080	121	128	34	0		13208	63988	65320	9016	2424	19444
14	1	16:10:49.100	58249.100	123	130	34	0		13208	63988	65324	9016	2420	19440
15	1	16:10:49.120	58249.120	126	130	34	0		13208	63988	65324	9016	2420	19440
16	1	16:10:49.140	58249.140	126	131	34	0		13212	63988	65324	9012	2416	19436
17	1	16:10:49.160	58249.160	125	132	34	0		13208	63988	65324	9012	2420	19440
18	1	16:10:49.180	58249.180	125	128	34	0		13208	63992	65324	9016	2420	19440
19	1	16:10:49.200	58249.200	125	127	34	0		13208	63988	65320	9004	2424	19444
20	1	16:10:49.220	58249.220	127	126	34	0		13208	63984	65320	9004	2424	19440
21	1	16:10:49.240	58249.240	128	125	34	0		13208	63984	65320	9004	2432	19444
22	1	16:10:49.260	58249.260	128	126	34	0		13204	63988	65320	9012	2428	19444
23	1	16:10:49.280	58249.280	128	127	34	0		13200	63988	65320	9008	2432	19444
24	1	16:10:49.300	58249.300	127	128	34	0		13200	63988	65320	9004	2428	19444
25	1	16:10:49.320	58249.320	125	128	35	0		13196	63988	65320	9008	2428	19444
26	1	16:10:49.340	58249.340	124	128	34	0		13196	63988	65316	9008	2432	19452
27	1	16:10:49.360	58249.360	123	128	35	0		13196	63992	65316	9012	2432	19448
28	1	16:10:49.380	58249.380	124	126	35	0		13196	63988	65316	9008	2432	19452
29	1	16:10:49.400	58249.400	124	125	35	0		13196	63988	65312	9012	2436	19456
30	1	16:10:49.420	58249.420	124	126	35	0		13196	63992	65312	9016	2432	19452
31	1	16:10:49.440	58249.440	125	124	35	0		13196	63992	65312	9016	2432	19452
32	1	16:10:49.460	58249.460	125	124	35	0		13196	63992	65312	9016	2432	19452
33	1	16:10:49.480	58249.480	125	125	35	0		13196	63988	65312	9012	2432	19456

Figure 1. Eyedat file

2.1 Data Columns

Once a data file has been opened several columns of data will be shown. The file name and number of segments will appear in a file tree format on the left side of the program screen. A segment is considered the length of time between a start and stop of recording on the same data file. Depending on the system configuration used while recording data these columns will differ from figure 1.

2.1.1 Eyedat Files

An Eyedat file, the standard type of file recorded with ASL's remote (table mounted pan/tilt or Long Range) optics, has a ***.eyd*** extension. A standard Eyedat file will have nine data columns.

1. **Field No.** A field refers to the data items recorded for a single sampling interval. A sampling interval is a 50th, 60th, 120th, or 240th of a second, depending on the model eye tracker system used. A field contains eight pieces of data represented by rows.

2. **Segment No.** A segment is a continuous section of recorded data. Every time data recording is paused, and restarted without closing the data file, a new data "segment" is created on that file; so a data file may have one or more segments. This column will list the segment of the data file containing the corresponding field (row) of data. All files have a segment maximum of 169. Note: segments exceeding approximately 5 min may be divided into pseudo segments which count toward the segment maximum.

3. **Time** PC time of day (hours:minutes:seconds) at which the field was recorded .

4. **Total Seconds** Same as Time, but displayed as the number of seconds since midnight.

5. **H-POS** Horizontal Eye Position

6. **V-POS** Vertical Eye Position

7. **Pupil Diam** Horizontal pupil diameter measure in pixels. This measure can be scaled to mm.

8. **X-DAT** External Data, this column will show the value that was on the eye tracker parallel, external data (XDAT) port during the data field.

9. **Mark** This column will show any manual event marks entered into the data file by the operator from the e5win program. These marks can be 0-9.

If using a model 504 Pan/Tilt with Magnetic Head Tracker option an additional six columns of MHT data will also be displayed.

10. **MHT X** Sensor location in the transmitter X-axis
11. **MHT-Y** Sensor location in the transmitter Y-axis
12. **MHT-Z** Sensor location in the transmitter Z-axis
13. **AZIMUTH** Sensor orientation
14. **ELEVATION** Sensor orientation

15. **ROLL** Sensor orientation

2.1.2 EYEHEAD Data Files

An EYEHEAD data file, recorded with head mounted optics and ASL's EYEHEAD™ Integration feature, has an ***.ehd*** extension. A Standard EYEHEAD data file will contain 11 columns of data.. EYEHEAD data includes the computed intersection for line of gaze on one to twenty individual surfaces (scenes), subject eye to scene distance and pupil diameter. The intersection is defined in specified units (inches or cm). All files have a segment maximum of 169. Note: segments exceeding approximately 5 min may be divided into pseudo segments which count toward the segment maximum. See figure 2.

NOTE: there are other data items that can be output for EYEHEAD™ Integration the below description relates only to a standard EYEHEAD™ data file. Non-standard data files can contain raw eye position in the head and 6 columns of head position in addition to the standard data items. Consult Technical Support for additional information

1. **Field No.** A field refers to the data items recorded for a single sampling interval. A sampling interval is a 50th, 60th, 120th, or 240th of a second, depending on the model eye tracker system used. A field contains eight pieces of data represented by rows.

2. **Segment No.** A segment is a continuous section of recorded data. Every time data recording is paused, and restarted without closing the data file, a new data "segment" is created on that file; so a data file may have one or more segments. This column will list the segment of the data file containing the corresponding field (row) of data

3. **Time** PC time of day (hours:minutes:seconds) at which the field was recorded

4. **Total Seconds** Same as Time, but displayed as the number of seconds since midnight.

5. **Magnitude** Eye to point-of-gaze distance.

6. **Scene** Indicates which scene plane the subject was looking at during that field.

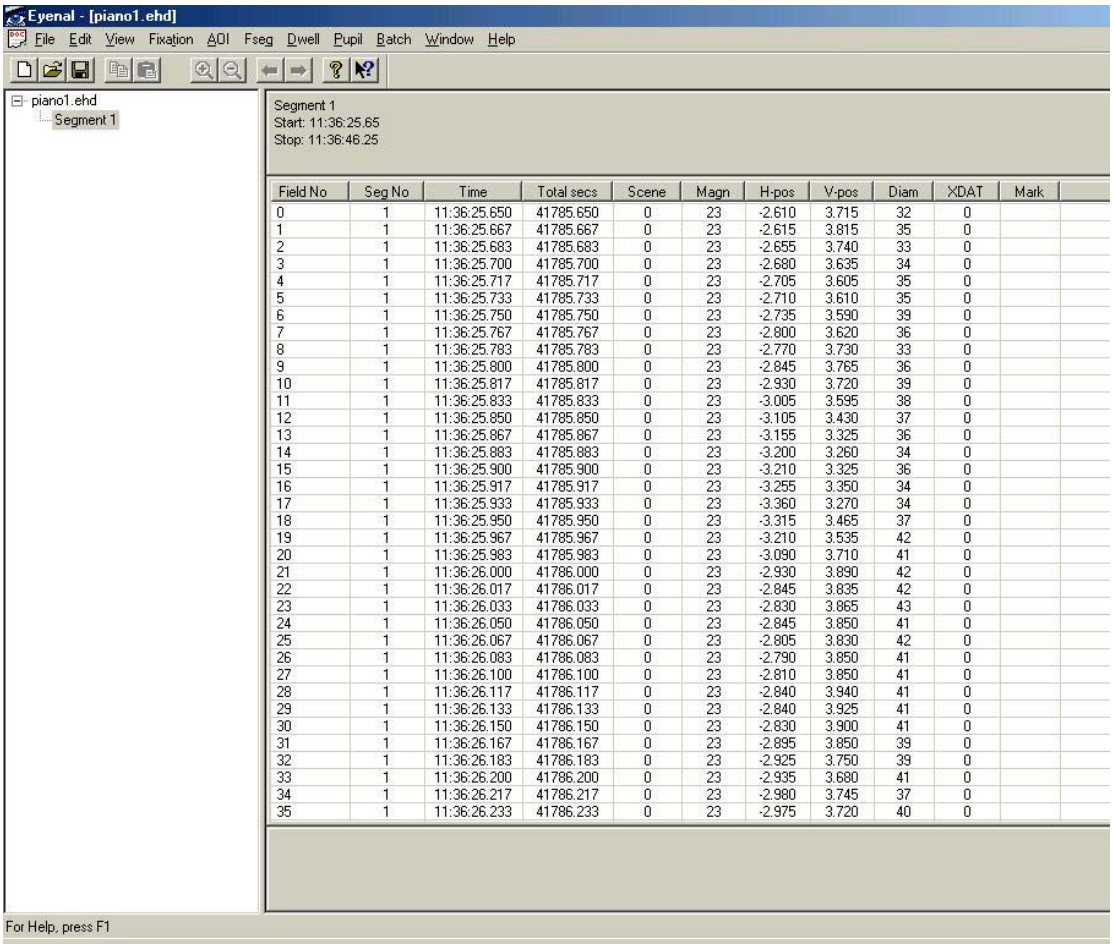
7. **H-POS** Horizontal Eye Position (point of gaze) on the indicated scene plane.

8. **V-POS** Vertical Eye Position (point of gaze) on the indicated scene plane.

9. **Pupil Diam** Horizontal pupil diameter measure in pixels. This measure can be scaled to mm.

10. **X-DAT** External Data, this column will show the value that was on the eye tracker parallel, external data (XDAT) port during the data field.

11. **Mark** This column will show any manual event marks entered into the data file by the operator from the e5win program. These marks can be 0-9.



Field No	Seg No	Time	Total secs	Scene	Magn	H-pos	V-pos	Diam	XDAT	Mark
0	1	11:36:25.650	41785.650	0	23	-2.610	3.715	32	0	
1	1	11:36:25.667	41785.667	0	23	-2.615	3.815	35	0	
2	1	11:36:25.683	41785.683	0	23	-2.655	3.740	33	0	
3	1	11:36:25.700	41785.700	0	23	-2.680	3.635	34	0	
4	1	11:36:25.717	41785.717	0	23	-2.705	3.605	35	0	
5	1	11:36:25.733	41785.733	0	23	-2.710	3.610	35	0	
6	1	11:36:25.750	41785.750	0	23	-2.735	3.590	39	0	
7	1	11:36:25.767	41785.767	0	23	-2.800	3.620	36	0	
8	1	11:36:25.783	41785.783	0	23	-2.770	3.730	33	0	
9	1	11:36:25.800	41785.800	0	23	-2.845	3.765	36	0	
10	1	11:36:25.817	41785.817	0	23	-2.930	3.720	39	0	
11	1	11:36:25.833	41785.833	0	23	-3.005	3.595	38	0	
12	1	11:36:25.850	41785.850	0	23	-3.105	3.430	37	0	
13	1	11:36:25.867	41785.867	0	23	-3.155	3.325	36	0	
14	1	11:36:25.883	41785.883	0	23	-3.200	3.260	34	0	
15	1	11:36:25.900	41785.900	0	23	-3.210	3.325	36	0	
16	1	11:36:25.917	41785.917	0	23	-3.255	3.350	34	0	
17	1	11:36:25.933	41785.933	0	23	-3.360	3.270	34	0	
18	1	11:36:25.950	41785.950	0	23	-3.315	3.465	37	0	
19	1	11:36:25.967	41785.967	0	23	-3.210	3.535	42	0	
20	1	11:36:25.983	41785.983	0	23	-3.090	3.710	41	0	
21	1	11:36:26.000	41786.000	0	23	-2.930	3.890	42	0	
22	1	11:36:26.017	41786.017	0	23	-2.845	3.835	42	0	
23	1	11:36:26.033	41786.033	0	23	-2.830	3.865	43	0	
24	1	11:36:26.050	41786.050	0	23	-2.845	3.850	41	0	
25	1	11:36:26.067	41786.067	0	23	-2.805	3.830	42	0	
26	1	11:36:26.083	41786.083	0	23	-2.790	3.850	41	0	
27	1	11:36:26.100	41786.100	0	23	-2.810	3.850	41	0	
28	1	11:36:26.117	41786.117	0	23	-2.840	3.940	41	0	
29	1	11:36:26.133	41786.133	0	23	-2.840	3.925	41	0	
30	1	11:36:26.150	41786.150	0	23	-2.830	3.900	41	0	
31	1	11:36:26.167	41786.167	0	23	-2.895	3.850	39	0	
32	1	11:36:26.183	41786.183	0	23	-2.925	3.750	39	0	
33	1	11:36:26.200	41786.200	0	23	-2.935	3.680	41	0	
34	1	11:36:26.217	41786.217	0	23	-2.980	3.745	37	0	
35	1	11:36:26.233	41786.233	0	23	-2.975	3.720	40	0	

Figure 2. Eyehead data file

3. Calculate Fixations

3.1 Purpose and Application

The FIX function reduces raw eye position data on an EYEDAT or EYEHEEAD file to a series of fixation points and recorded on another file. The term fixation refers to a person's point-of-regard as one looks at a stationary target in a visual field. Fixations are distinguished, primarily, from saccades (rapid voluntary eye movements used to move from one fixation point to another) and very small involuntary eye movements of several types which occur during fixation.

There is currently no precise, universally accepted definition of a fixation, but there are known parameters of ocular physiology which allow reasonable criteria to be used. Specifically, there is research documenting the minimum latency of saccades in response to visual stimuli (thus suggesting a minimum fixation duration) and data defining the maximum amplitude of involuntary eye movements during the fixation (thus establishing maximum fixation boundaries).

A fixation as computed by FIX, may be thought of as the mean X and Y eye position coordinates measured over a minimum period of time during which the eye does not move more than some maximum amount. More simply stated, point-of-gaze must continuously remain within a small area for some minimum time. If **default** values are used, maximum change in gaze point is 1 degree visual angle, and the minimum time is 100 msec.

User Adjustable: Several parameters used by the algorithm can be set by the user. Although default values are specified in this manual, it is important that the user examine output from FIX to verify that the program is processing fixations properly.

3.2 Making a Fixation File

To make a Fixation file:

1. select the Fixation pull down menu.
2. Choose "Make a new Fixation file"
3. The Fixation Properties window will pop up:
   - **a.** **Name:** This is the output file name. The default name will be taken from the current EYEDAT file and given a ***.fix*** extension. If desired rename the output file.
   - **b.** **Code:** Information typed here shows up in the file header.
   - **c.** **Title:** Information typed here shows up in the file header.

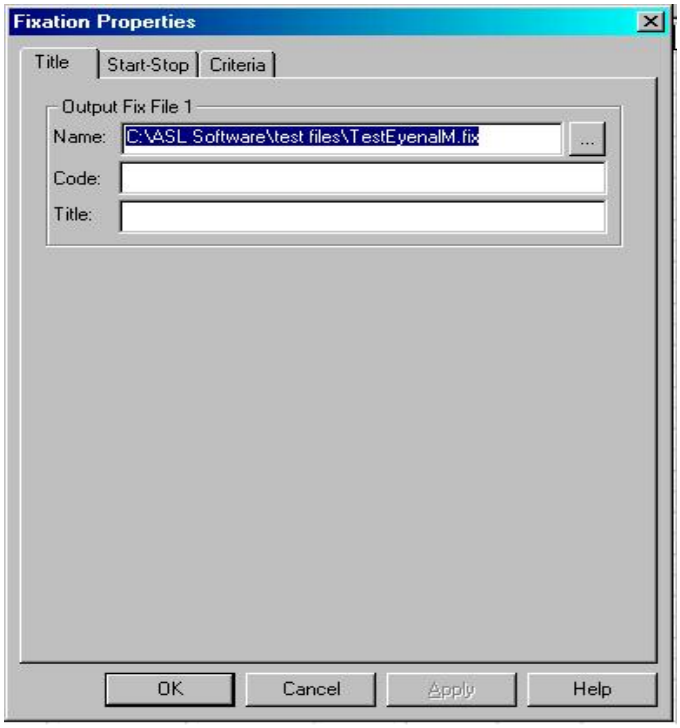


Figure 3

4. Click "Start-Stop" tab and set Start and Stop properties.

5. Click the "Criteria" tab and set properties.

6. Click "OK"

3.2.1 Start-Stop Criteria

The Start-Stop Criteria menu allows the user to specify a particular duration of the of the raw data for analysis.

- **Start Point:** A Fseq file can be made with only a portion of the fixation source file. A start point can be designated by segment <**Segm:**>or by time <**Delay (secs**)>.
- **Stop Point:** It is possible to have a Fseq file made with only a portion of the fixation source file. A stop point can be designated by segment <**Segm:**>or by time <**Duration (secs**)>.
- **Flags**
  - **a. Use start flag:** Mark or X-DAT values may be used as flags to trigger the beginning of fixation calculations. Check this box to use a start flag then specify the appropriate flag in one of the two boxes to the right.. **NOTE:** For more information on Marks and X-DAT refer to the ASL Model 501/504 user manual.
  - **b. Use stop flag:** Mark or X-DAT values may be used as flags to trigger the end of fixation calculations. Check this box to use a stop flag then specify the appropriate flag in one of the two boxes to the right. **NOTE:** For more information on Marks and X-DAT refer to the ASL Model 501/504 user manual.

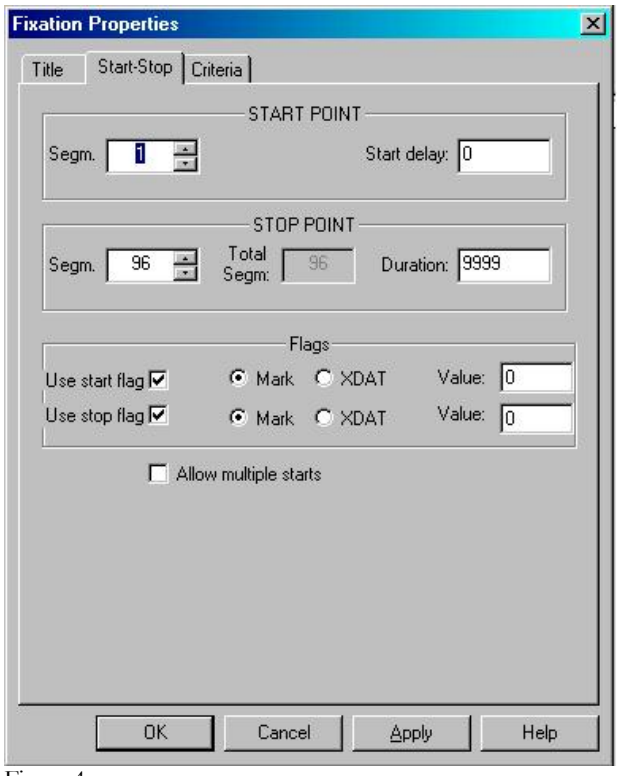


Figure 4

- **c. Allow multiple starts:** If this box is checked Eyenal will begin analyzing the raw data a the first occurrence of a specified start flag and stop at the specified point ***then*** continue to look for subsequent occurrences of the specified start flag and create multiple segments on the resulting Fixation file.

NOTE: start and **stop flags** may be combined with **Start** and **Stop Points**.

3.2.2 Fixation Criteria

The Fixation Criteria menu allows the user to set parameters used by the algorithm to detect a fixation.

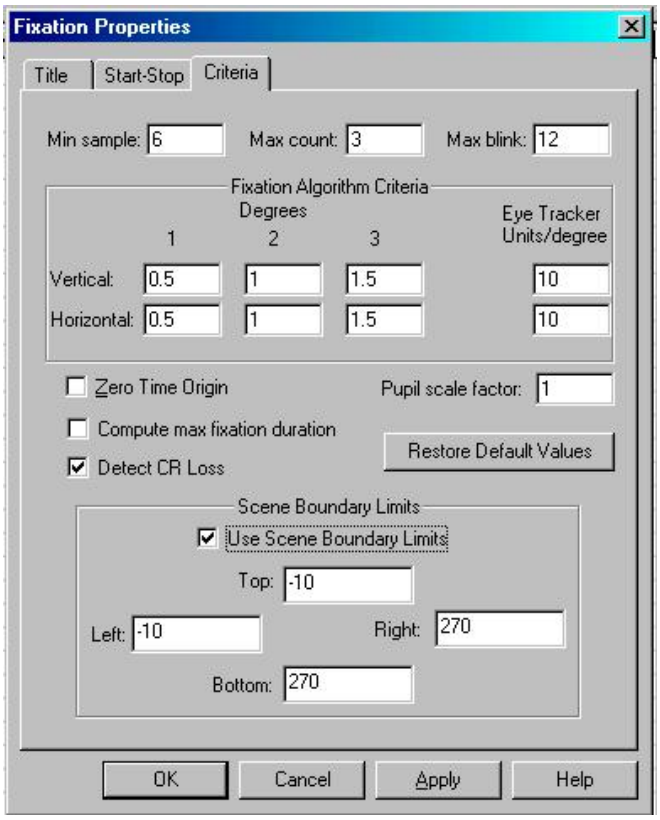


Figure 5

3.2.2.1 Brief Description of Fixation Algorithm

Criterion 1 is used to determine when a fixation starts; Criterion 2 is used to determine whether subsequent data samples are part of the same fixation; and Criterion 3 is used to determine which data samples should be averaged together to determine the final fixation coordinates. The quick description is as follows. To "start a fixation" the program looks for a specified period (MIN SAMPLE) during which gaze has a standard deviation of no more than a specified amount (Criterion-1). To end the fixation, it looks for a specified number of sequential gaze position samples (MAX COUNT) to be farther than a specified distance (Criterion-2) from the initial fixation position. The final fixation position is the average position of all data samples between the beginning and end of the fixation. The exception is that any gaze coordinates that were farther than criterion-3 from the initial fixation position are not included in the average. For more information please see section 3.2.2.3 and a detailed explanation in section 3.2.5.

3.2.2.2 Fixation Criteria Menu Options

The following is a list of the adjustable settings of the Fixation Criteria Menu including those for the fixation detection algorithm. The criteria are listed as they appear in the Criteria menu(figure 4).

- **Min Sample** To "start a fixation" the program looks for a specified period (MIN SAMPLE) during which gaze has a standard deviation of no more than a specified amount (Criterion-1).

- **Max Count** To end the fixation, it looks for a specified number of sequential gaze position samples (MAX COUNT) to be farther than a specified distance (Criterion-2) from the initial fixation position.

- **Max Blink** If the number of consecutive lost data fields (pupil diameter =0) in an EYEDAT data sample is less than the defined Max Blink number of fields than the losses are considered a blink .A number of consecutive lost fields greater than the maximum are considered losses. If a loss occurs during a fixation and is less than the value you set as "Max Blink", then the loss does not cause the fixation to end. If the loss is longer than "Max Blink" the fixation is considered to have ended with the last field before the loss.

- **Vertical 1 2 3 and Eyetracker Units/degree** This row contains the values (in degrees) for criteria 1-3 pertaining to the vertical axis. The box in the last column is for the number of Eye tracker units that equal 1 degree visual angle in the vertical axis. See section 3.2.1.3 for further description.

- **Horizontal 1 2 3 and Eyetracker Units/degree** This row contains the values (in degrees) for criteria 1-3 pertaining to the horizontal axis. The box in the last column is for the number of Eye tracker units that equal 1 degree visual angle in the horizontal axis. See section 3.2.1.3 for further description.

- **Zero Time Origin** If this box is checked, the time value at the start of the segment processed will be set to **00:00:00.000**. This option only effects the output file.

- **Pupil scale factor** Pupil diameter may be scaled to meaningful units such as millimeters. To compute a scale factor for pupil diameter values displayed by or recorded on the Interface program :

    1. First place the Model Eye at the same eye to camera distance present during experimental conditions.
    2. Second obtain proper discrimination on the model pupil.
    3. Third note the pupil diameter value on the interface screen digital display window ("Pupil Diameter: *nnn*").

To compute a scale factor, divide the recorded value by **3.96** (the diameter of the Model Eye pupil). Convert displayed or recorded pupil diameter values to millimeters by applying this scale factor (value in millimeters = scale factor * recorded value). See the 501.504 Manual section "Using the Model Eye" for more information.

- **Compute max fixation duration** Checking this box will result in Eyenal computing the longest possible fixation duration. The below explanation describes the default (or mid range possibility) versus Max duration computation

Fixation time and lose time are computed by taking the number of data samples that are part of a fixation (or loss) and multiplying by the update interval. For example, assuming a 50 Hz system, if 10 data samples are found to be part of a fixation the fixation duration is given as 10*20 ms = 200 ms.

Note that actually this is the maximum possible fixation duration since it assumes that the fixation stated at the beginning of the first sample and ended at the end of the last of these samples. The uncertainty associated with taking discrete samples means that this fixation could actually be as short as 160 ms (starts near the end of the first sample and ends near the beginning of the last sample) or as long as 200. This version of Eyenal (ver1.28) chooses the mid range possibility and reports 180 ms in this example. Currently Eyenal will use the format of the mid range possibility when computing fixation duration and includes an optional check box to compute the longest possibility as was the case with all previous versions of Eyenal (both DOS and Windows).

- **Detect CR Loss** Head mounted eyetrackers(E.g., model 501) can measure line of gaze, although with reduced accuracy, even when only the pupil is recognized. Remote(non head mounted) systems, which permit motion of the head with respect to the eye camera(E.g., model 504), **cannot** make a reasonable gaze measurement unless both the CR and pupil are recognized.

  When a remote system recognizes the pupil but not the CR, it continues to report a valid pupil diameter, but sets eye position values to default values. These default coordinates are zero(0) for series 5000 systems and twenty(20) for series 4000 systems. If "Detect CR Loss" is enabled, eye position coordinates of these default values will be interpreted as "not valid data"(even though pupil diameter is not zero) and the data will not be incorrectly interpreted as fixations at these positions.

  If analyzing data from a remote eye tracker it usually makes sense to enable "Detect CR Loss" by checking this box.

  If analyzing data from a system with head mounted optics, it is usually best to disable this feature by leaving this box unchecked.

- **Scene Boundary Limits**
  N/A with EYEHEAD data files (.ehd)
  If this feature is enabled and if the eye point of gaze position is outside of the defined scene boundary limits, this is treated as "not valid data". This provides a means of filtering out "ridiculous" data values that may occur for example, if some extraneous reflection is recognized as the pupil or CR.

  It makes most sense to use this feature when analyzing data from a remote eye tracker which we know can make valid measurements only when the subject looks within about 25 degrees visual angle of the optics module. If for example, the subject was looking at a computer monitor scene, data values that would indicate gaze points many feet from the scene are unlikely to be valid data and can be filtered out. Set boundary limits that define a region within which it is reasonable to expect valid gaze data

Check the box to enable the scene boundary limit feature, then type in the top, bottom, left and right coordinates of the scene boundaries. The ASL system divides any scene plane into a grid space of 260 by 240; thus all gaze coordinates reported beyond 0,0 and 260,240 are theoretically outside the plane of interest. Default values are *top:-10, left -10, right 270, and bottom 270* because it is possible for the system to make valid gaze measurements just beyond the boundary limits and taking into account the systems accuracy.

3.2.2.3 Fixation Algorithm Criteria Description

Criteria 1, 2 and 3 are defined in terms of visual angle(eyeball rotation angle). These criteria are user adjustable.

For small visual angles in the center of the scene, **d = s * tan x**

- where **d** is the distance on the scene,
- **s** is the subject's eye to scene distance,
- **x** is the visual angle.

Thus if the subject is seated 57.3 inches from the scene a square covering 1 degree visual angle would measure 1 inch by 1 inch.

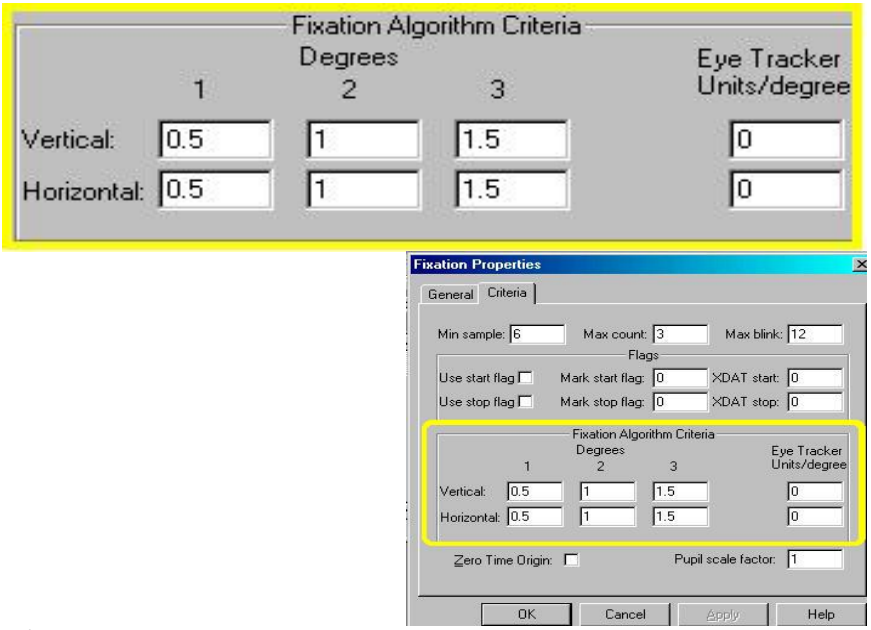


Figure 6

- **Eye Tracker Units/degree**

  N/A for EYEHEAD data files[1]

  Eyedat files,(e.g., data gathered with the model 504 pan tilt optics) do not contain the information about subject to scene distance or scene camera position and magnification that is required to express the point of gaze data in terms of visual angles(degrees of eye ball rotation). **The program must be**

[1] ***EYEHEAD** Integration data (data gathered with head mounted optics, a magnetic head tracker, and ASL's EYEHEAD™ Integration software) contains enough information for the program to compute visual angles.

told how many "eye tracker data units" correspond to a degree of visual angle. This ratio(eye tracker units per degree visual angle) must be determined for both the horizontal and vertical axis and is entered under a label named " Eye tracker Units/degree". The following subsection explains how this parameter can be determined.

3.2.3 Visual Angle Computation

The following is a suggested procedure for determining eye tracker units per degree of visual angle. Please note that this computation is not necessary for EYEHEAD data. In addition there is a Visual Angle Calculator application that can perform this operation. The Visual Angle calculator application is available for download on ftp://a-s-l.com/pub/Visual Angle Calculator

1. Measure the distance in inches(or centimeters) from the subject eye to the center of the scene plane. Call this "s".

1. Measure the distance in inches(or centimeters) horizontally between two known scene points, such as the points 5 and 6 on the calibration chart. Call this "dh".

1. Measure the distance in inches(or centimeters) vertically between two known scene points, such as the points 5 and 2 on the calibration chart. Call this "dv".

2. Use the Set Target mode of the Eyetracker Software while observing the scene monitor. Now measure the distance in Eyetracker units horizontally between the two known scene points(points 5 and 6 on the calibration chart). Call this "ETh".

3. Next measure the distance in Eyetracker units vertically between the two known scene points(points 5 and 2 on the calibration chart). Call this "ETv".

4. Find the angle whose tangent is dh/s and call this "θh".

5. Find the angle whose tangent is dv/s and call this "θv".

6. Divide ETh by θh

7. This is the value of eye tracker units per degree visual angle along the horizontal axis.

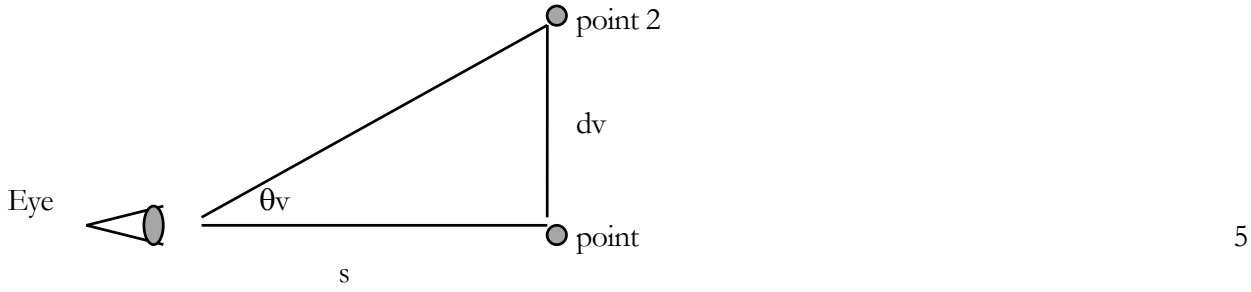
8. Divide ETv by θv. This is the value of eye tracker units per degree visual angle along the vertical axis.

3.2.4 Sample Calculations of Eye Tracker Units per Degree Visual Angle

The following are sample calculations to determine eye tracker units per degree of visual angle.

Sample Measurements

s = Eye to center of scene distance = 28 inches
dh = Horizontal distance from calibration point 5 to point 6 = 8 inches
Eth = number of horizontal eyetracker units between points 5 and 6 = 120 Eyetracker units.
dv = Vertical distance from calibration point 2 to point 5 = 7 inches
Etv = number of vertical Eyetracker units between points 2 and 5 = 105 eyetracker units



Sample Calculations:

$\theta h = \tan^{-1}(dh/s) = 15.9$ deg Horizontal eyetracker units per degree = 120/15.9 = 7.5

$\theta v = \tan^{-1}(dv/s) = 14$ deg Vertical eyetracker units per degree = 105/14 = 7.5

3.2.5 Detailed Fixation Determination Algorithm

A three boundary approach is used to define fixations. The recommended values for the three boundaries (called criterion 1, 2, and 3) are 0.5 degrees, 1.0 degree, and 1.5 degrees respectively. These values may be reset as described in Section 3.2.2.

The program uses a moving window technique to find the fixation start point. The first "min sample" data samples are examined. "Min sample" is adjustable as described in Section 8.4.1, but it is usually set to the number of fields that will correspond to about 100 msec. If the standard deviations of the X (horizontal) and Y (vertical) eye position coordinates is less than "criterion 1", the means of this sample are used as temporary fixation coordinates (XT, YT). If the standard deviation was greater than criterion 1, then the min-sample window is moved up one field and the calculations repeated until a min-sample window which passes criterion 1 is found.

Once a fixation start point is determined, the program calculates the horizontal and vertical distance (DX, DY) of the next data sample from the temporary means (XT, YT). If (DX, DY) is less than criterion 2, the sample is included in the fixation. If it does not pass criterion 2, then the next sample is tested against criterion 2.

This process is continued until a measurement sample passes criterion 2 or until "max count" sequential samples (default value of three can be changed by the user) have been tested. If one of these

measurements does fall within criterion 2, previous samples that did not are tested against criterion 3. All of the samples that pass criterion 2 or 3 are then considered to be "included in the fixation." This means that they will be used in the final calculation of fixation position.

If DX and/or DY from "max-count" sequential samples exceed criterion 2 then the X and Y means of these samples are calculated. If the means do not differ from XT and YT by more than criterion 2, they are all included in the fixation; otherwise the fixation is closed at the last acceptable data sample.

Blinks, defined as pupil losses of "max blink"samples or less, are ignored and do not terminate a fixation. Note that a number of samples equal to about 200 msec is the recommended value for maximum blink duration. This value may be reset as described in Section 3.2.2. Pupil loss for periods longer than "max-blink" do cause a fixation to close at the last acceptable data sample.

4. Define Areas of Interest (AOIs)

4.1 Purpose and Application

The Area of Interest(AOI) function defines up to 50 Areas of Interest on the visual scene viewed by an Eyetracker subject. Areas of Interest are defined as rectangles and may be assigned labels of up to ten characters. Once and AOI file exits EYENAL can calculate statistics on time subjects spent viewing various scene elements and the sequence in which they were viewed. The AOI function allows the user to create, edit, draw, print, and save Area of Interest (AOI) coordinates on files for future use by EYENAL FSEQ, and DWELL functions or possibly other data analysis programs.

For non-EYEHEAD systems, the coordinates of each AOI top, bottom, left, and right boundaries can be determined by using the Eyetracker Set Target function (see Eyetracker Manual) . Area of Interest coordinates should be specified to the AOI function in Eyetracker coordinates. Scene plane 0 is the Eyetracker calibration plane and is the only plane defined for non-EYEHEAD systems.

EYEHEAD™ Integration AOI files can be defined for up to twenty scene planes. The coordinates for top, bottom, left, and right boundaries of each area in each scene plane are defined in inches or centimeters with respect to the coordinate frame defined on each EYEHEAD scene plane(See EYEHEAD manual for explanation of EYEHEAD scene planes).

Fixplot: AOI files can also be made using the Fixplot program. Fixplot allows the user to draw Areas of interest over any bitmap image rather than define them with coordinates. AOI files made using Fixplot can be used in EYENAL. (See the Fixplot manual for further information)

4.2 Creating an AOI file

To create an AOI file:

1. Open the **AOI pull down Menu**
2. Select "Make new AOI file"
3. Once the **Area of Interest Properties menu** pops up, fill in the appropriate information and coordinates. Proceed as follows

   A. **File Name:** enter a name for the new AOI file to be created. NOTE if a data file is currently open the program will display a default file name. The default file name will be the data file title with an ***.aoi*** extension.

   B. If using EYEHEAD™ Integration data

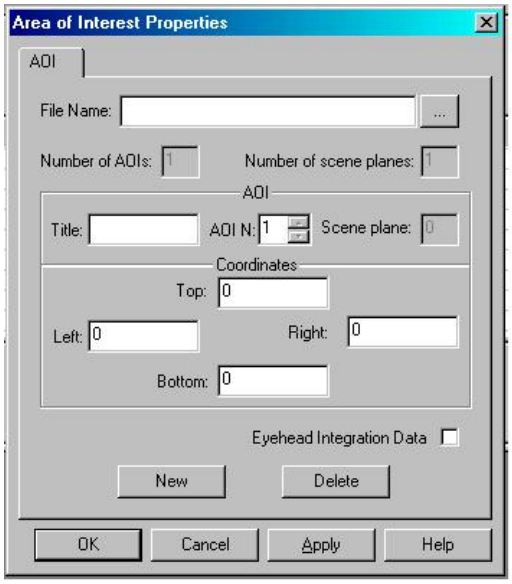


figure 7

check the box in the bottom right of the menu.

C. **Title:** enter the title for the first area you wish to create. This name will be given to the area designated in the **AOI N** (area of interest number) box..

D. **Scene Plane:** If using EYEHEAD™ Integration data only. If using EYEHEAD data specify the scene (0-19) that contains the current Area.

E. **Top:** enter Top coordinate

F. **Left:** enter Left coordinate

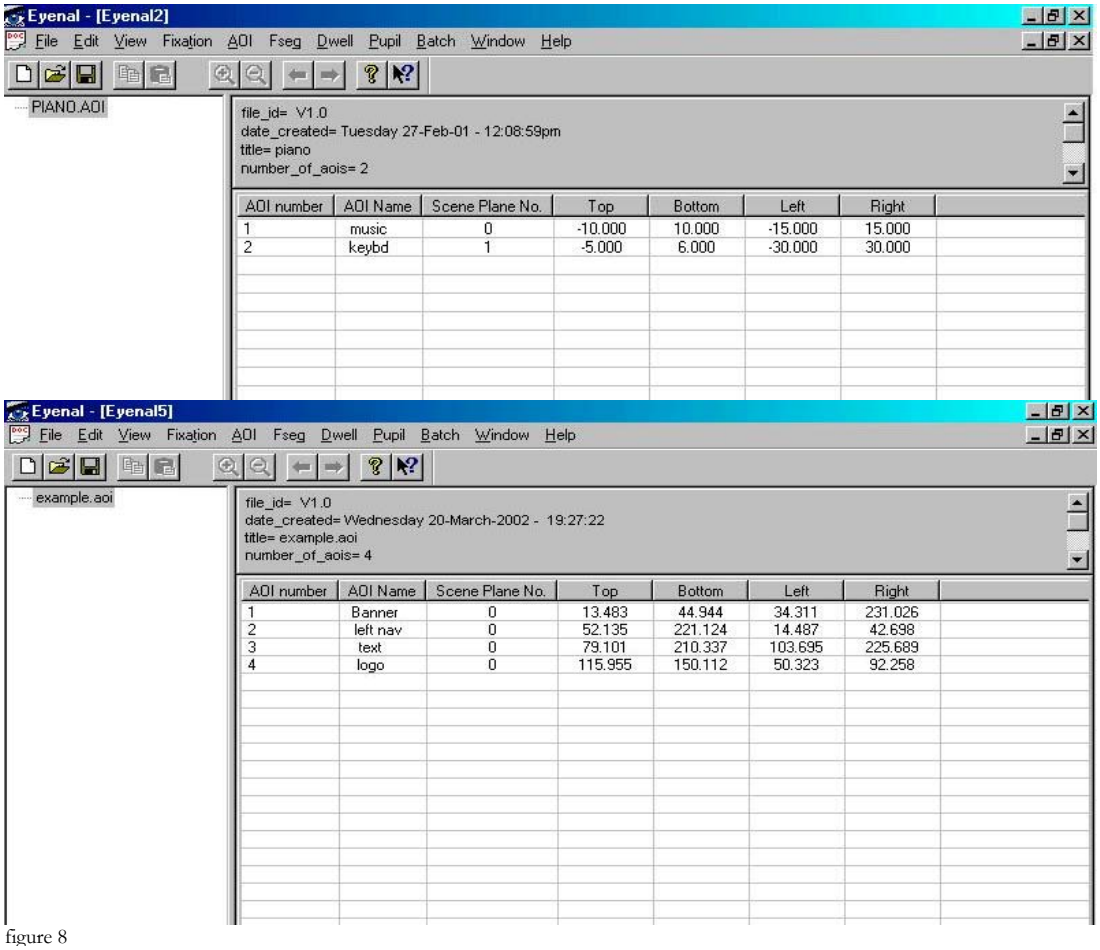
G. **Right:** enter Right coordinate

H. **Bottom:** enter Bottom coordinate

4. Select the "New" button to store the current Area and create another one on the same file. Repeat steps C-H..
OR
Select "OK" to save and create an AOI file based on the information entered into the AOI properties menu.

Example AOI file:

EYEHEAD™


Eyenal - [Eyenal2]
File Edit View Fixation AOI Fseg Dwell Pupil Batch Window Help
PIANO.AOI
file_id= V1.0
date_created= Tuesday 27-Feb-01 - 12:08:59pm
title= piano
number_of_aois= 2
AOI number | AOI Name | Scene Plane No. | Top | Bottom | Left | Right
1 | music | 0 | -10.000 | 10.000 | -15.000 | 15.000
2 | keybd | 1 | -5.000 | 6.000 | -30.000 | 30.000
Eyenal - [Eyenal5]
File Edit View Fixation AOI Fseg Dwell Pupil Batch Window Help
example.aoi
file_id= V1.0
date_created= Wednesday 20-March-2002 - 19:27:22
title= example.aoi
number_of_aois= 4
AOI number | AOI Name | Scene Plane No. | Top | Bottom | Left | Right
1 | Banner | 0 | 13.483 | 44.944 | 34.311 | 231.026
2 | left nav | 0 | 52.135 | 221.124 | 14.487 | 42.698
3 | text | 0 | 79.101 | 210.337 | 103.695 | 225.689
4 | logo | 0 | 115.955 | 150.112 | 50.323 | 92.258

nonEYEHEAD

figure 8

4.3 Editing an AOI file

To edit an AOI file:

1. Select the AOI pull down Menu

2. Choose "Open" and open desired AOI file

3. Once the desired file is open select "Edit" from the AOI pull down menu. This will bring up the Area of Interest Properties menu allowing you to edit any of the coordinates , titles or plane designations plus add a new area or delete an old one. Use the arrows to the right of the **AOI N** (area of interest number) box to select an area contained in the file.

4. When finished click "OK" to save the changes. It may be necessary to refresh the screen to view the changes outside the Area of Interest Properties window.

5. Fixation Sequence Analysis (FSEQ)

5.1 Purpose and Application

The FSEQ function is used to study the amount of time subjects spent viewing various scene elements and the sequence in which they were viewed. FSEQ matches fixation point data from files created by FIX(section 3.0) with Areas of Interest files created by AOI(section 4.0). FSQ determines the sequence of the areas fixated, a summary of the total time and percent of time spent fixating each area, and other summary statistics. In addition, the program calculates joint and conditional probability distribution between areas of interest. Output is to the monitor screen, a printer and/or an ASCII file as desired.

5.2 Making a Fseq File

To make an Fseq file:

1. Open desired Fixation file
2. Open desired AOI file
3. Select the **Fseq** pull down menu
4. Choose "Make new fixation sequence file"
5. Once the **Fixation Sequence Properties** menu pops up:

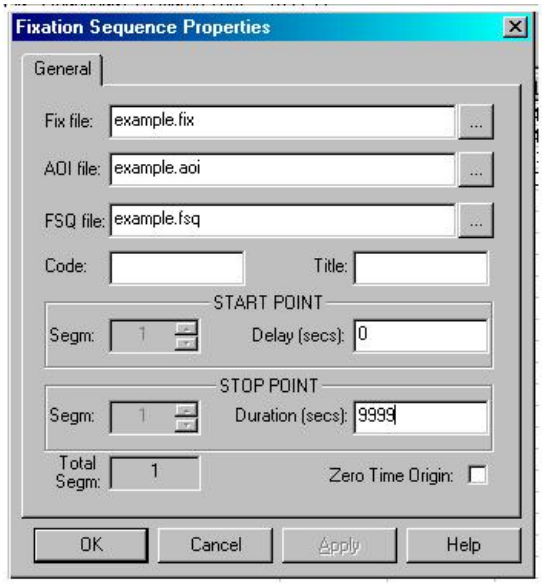


figure 9

   d. The Fseq Properties window should display the names of the desired **Fix** and **AOI** files. These are the input files.

   e. **FSQ file:** This is the output file name. The default name will be taken from the current Fix file and given a ***.fsq*** extension. If desired rename the output file.

   f. **Code:** Information typed here shows up in the file header

   g. **Title:** Information typed here shows up in the file header

   h. **Start Point:** A Fseq file can be made with only a portion of the fixation source file. A start point can be designated by segment <**Segm:**>or by time <**Delay (secs**)>.

   i. **Stop Point:** It is possible to have a Fseq file made with only a portion of the fixation source file. A stop point can be designated by segment <**Segm:**>or by time <**Duration (secs**)>.

   j. **Total Segm:** This box will display the total number of segments contained within the current Fixation file.

k. **Zero Time Origin:** If this box is checked, the time value at the start of the segment processed will be set to 00:00:00.000. This option only effects the output file.

5.3 Viewing a Fixation Sequence File

Once "OK" is selected from the Fixation Sequence Properties menu the Fixation Sequence List will be displayed in the EYENAL program window:

5.3.1 Fixation Sequence List

Each line of the Fixation Sequence list includes the following information (see figure 8):

- Fixation number
- Scene Plane, Name and number of the area of interest in which the fixation falls. If the fixation is on an area not specified as an area of interest, it is designated as "OFF." If overlapping Areas of Interest are defined and a fixation falls within the overlapping areas, the Fixation number will be repeated on subsequent lines and all such areas will be listed.
- Fixation start time in hours, minutes, and seconds (HH:MM:SS.SSS)
- Fixation Duration in seconds
- Interfixation length(between end of previous fixation and beginning of current fixation) in seconds
- Interfixation distance(between current and previous fixation) in degrees visual angle
- Scaled pupil diameter
- Eye to Scene Plane distance in inches or centimeters. This item is valid only for EYEHEAD data.

NOTE: that scene plane number, and eye to scene plane distance apply only to EYEHEAD data.

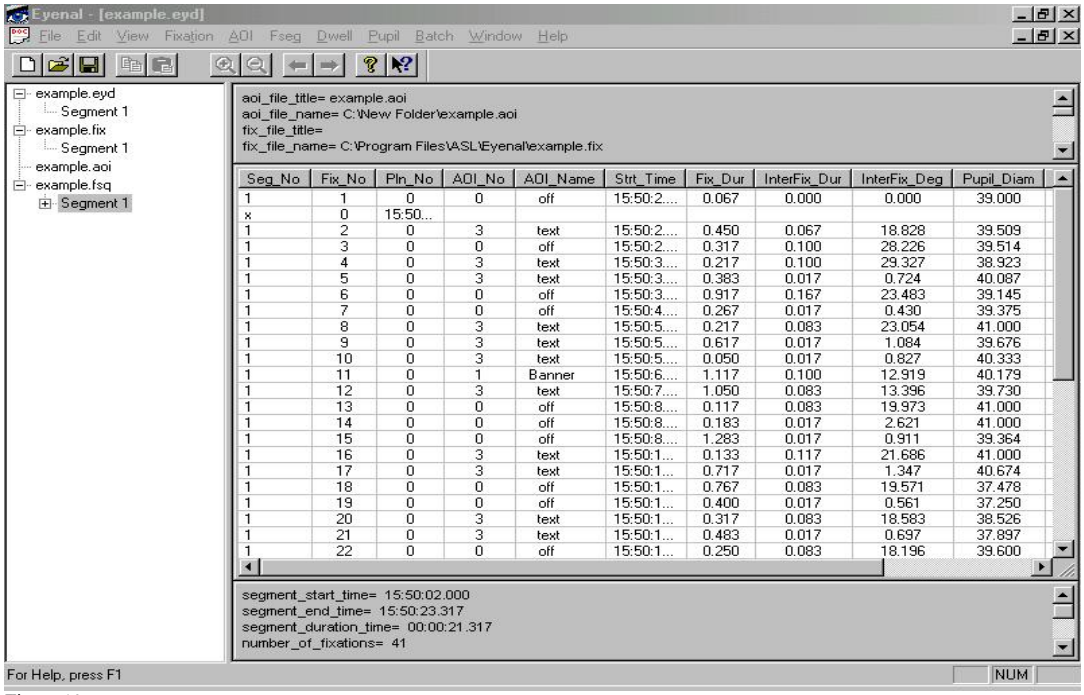


Figure 10

5.3.2 Fixation Sequence Segment Summary

The program lists the following summary information for each segment of data processed.

- Segment start time, stop time, and length of the data segment.
- Total number of fixations processed, and the mean fixation duration in seconds.
- Fixation Frequency (average number of fixations per second) during the data segment.
- Total loss time during the data segment. Loss time refers to time during which the pupil was not recognized by the Eyetracker. This includes some blink time.
- Mean interfixation distance. This distance is the average length between fixations in degrees of visual angle and was calculated using the Eyetracker Units/deg value as specified in the fixation program, or computed by the program from information in EYEHEAD files.

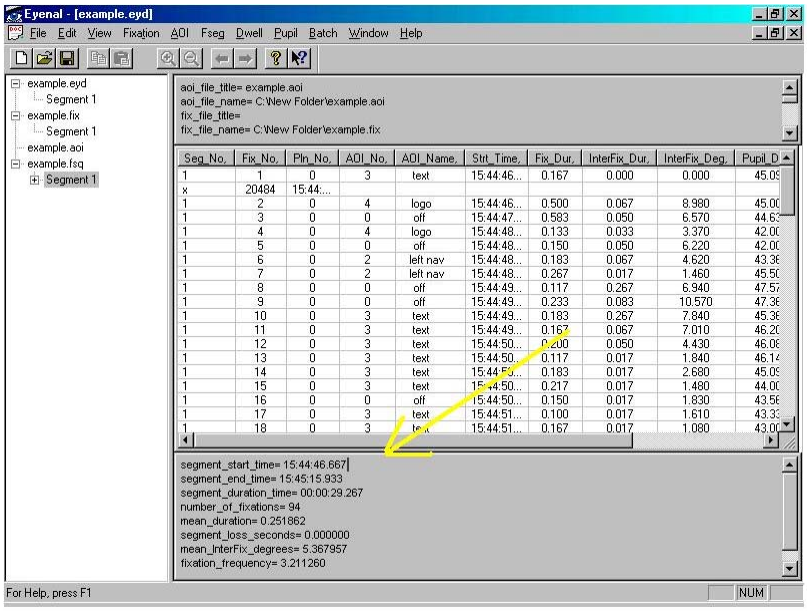
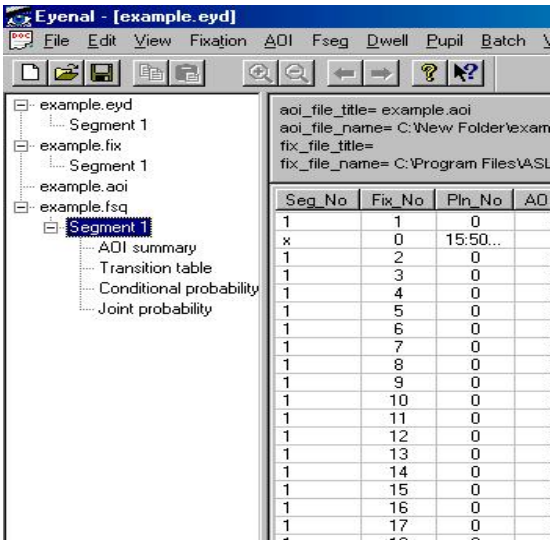


Figure 11

Navigation:

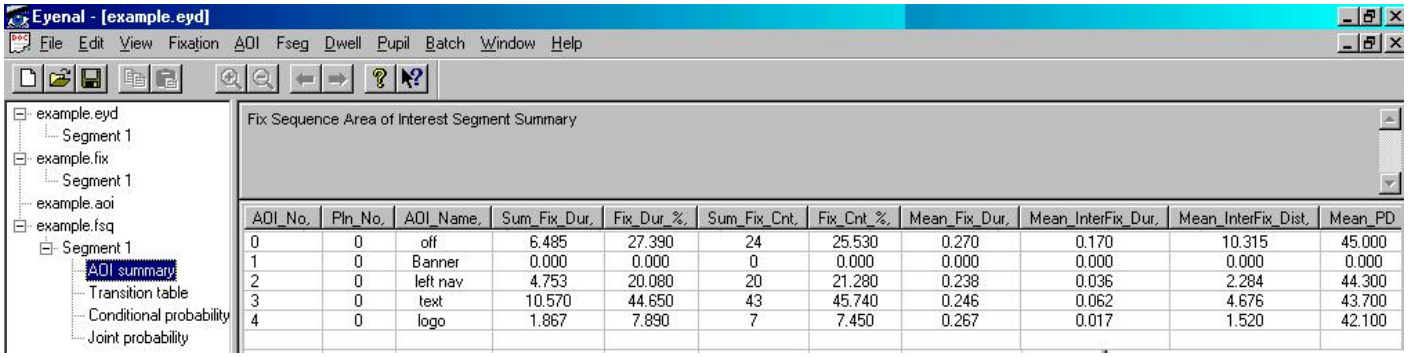
Left click on the + sign to extend the Fseq file tree.

Left click on any of the subsequent files to view contents.



5.3.3 Fixation Sequence Summary Table

The Fseq Summary Table lists the following information. To view the Fseq Summary table, click "AOI Summary" on the Fseq file tree.



AOI_No.	Pln_No.	AOI_Name.	Sum_Fix_Dur.	Fix_Dur_%.	Sum_Fix_Cnt.	Fix_Cnt_%.	Mean_Fix_Dur.	Mean_InterFix_Dur.	Mean_InterFix_Dist.	Mean_PD
0	0	off	6.485	27.390	24	25.530	0.270	0.170	10.315	45.000
1	0	Banner	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000
2	0	left nav	4.753	20.080	20	21.280	0.238	0.036	2.284	44.300
3	0	text	10.570	44.650	43	45.740	0.246	0.062	4.676	43.700
4	0	logo	1.867	7.890	7	7.450	0.267	0.017	1.520	42.100

Figure 12

- **Sum Fix Duration:** time for each AOI. This refers to the total time spent fixating a given area of interest during the data segment. Dwell time for each area of interest is listed both in seconds and as a percent of total fixation time during the data segment.

- **Sum Fix Cnt:** Total Number of fixations on each area.

- **Fix Cnt%:** Percent of fixations in each area (number of fixations on a given area divided by the total number of fixations).

- **Mean Fix Dur:** The mean duration in seconds, of fixations on each area (Dwell time divided by number of fixations).

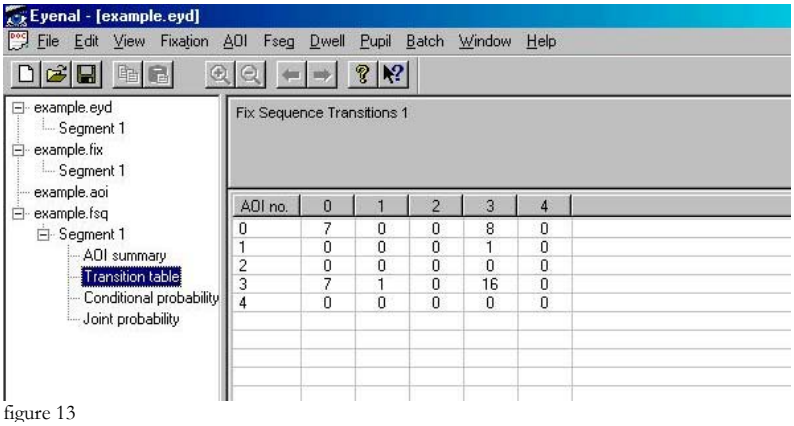
- **Mean Interfix Dur:** Mean interfixation length (in seconds) while subject was fixating in each AOI.

- **Mean Inter Fix Dist:** Mean interfixation distance (in degrees) while subject was fixating in each AOI.

- **Mean PD:** Mean pupil diameter for each AOI while subject was fixating on each AOI.

5.3.4 Transition Table

To view the Transition table. left click on "Transition table" in the Fseq file tree.



AOI no.	0	1	2	3	4
0	7	0	0	8	0
1	0	0	0	1	0
2	0	0	0	0	0
3	7	1	0	16	0
4	0	0	0	0	0

figure 13

Description: The Transition Table is a matrix representing the actual amount of transitional activity between Areas of Interest(AOI's). A transition from **i** to **j** is the change from a fixation in Area **i** to a new fixation in Area **j**.

Reading the Transition Table: Referring to the sample table above (figure 12), the left most column of numbers and the topmost row of numbers represent each AOI number. In this example there are four areas. There were 0 transitions between Area 0 (off the scene) to Areas 1, 2, and 4. There were 8 transitions between Area 0 and Area 3. There were 7 transitions from Area 0 to within area 0. There was 1 transition from Area 1 to Area 3. The highest transitional activity was with in Area 3.

5.3.5 Conditional Probability

To view the Conditional probability table, left click "Conditional probability" in the Fseq file tree.

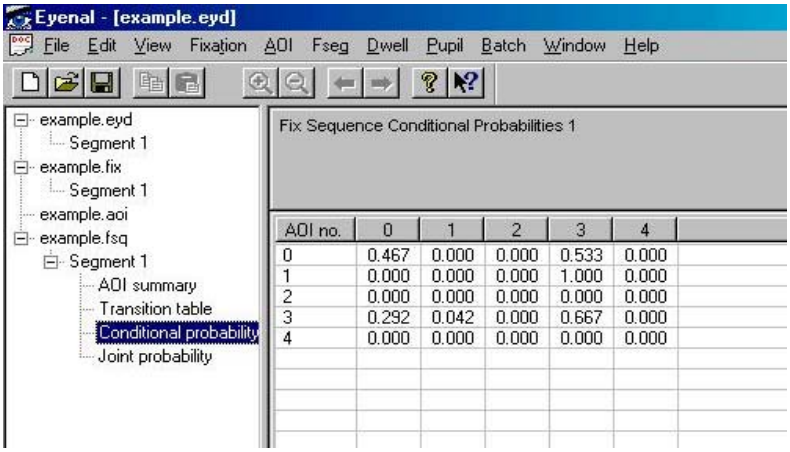


Figure 14

Definition: Conditional probability is the likelihood that given a fixation on one specific area, the next fixation will be on another specific area.

$$Pc(i/j) = \frac{\text{No. of fixation transitions from Ai to Aj}}{\text{No. of fixations on Ai}}$$

Reading the Conditional Probability Table: This table reads the same way as the transition table except that it is a matrix representing the conditional probability of transitional activity between Areas of Interest(AOI's).

> **NOTE:** Be careful about interpreting conditional probability results. If, for example, there are five areas of interest and out of 200 fixations a given subject looked at area 2 only once followed by a fixation on area 3, then the conditional probability(2,3) = 1.0 (or 100%). Obviously this does not mean that there was a lot of visual "traffic" between areas 2 and 3, but rather that whenever

there was a fixation on area 2 the next fixation was on area 3. In the example cited, the result is insignificant because of the small number of fixations on area 2.

5.3.6 Joint Probability Table

To view the Joint probability table, left click "Joint probability" in the Fseq file tree.

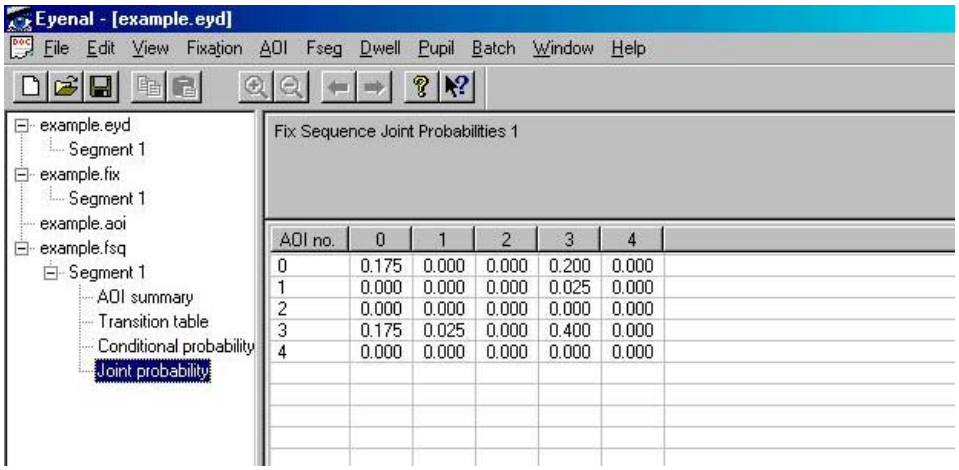


Figure 15

Definition: Joint probability is the relative likelihood (or relative frequency) of a transition between two particular areas as compared to transitions between other pairs of areas.

$$Pj(i,j) = \frac{\text{No. of fixation transitions from Ai to Aj}}{\text{Total number of transition pairs}}$$

Reading the Joint Probability Table: This table reads the same way as the transition table except that it is a matrix representing the joint probability of transitional activity between Areas of Interest(AOI's).

6. Dwell Statistics

6.1 Purpose and Application

The DWELL function computes various statistics from the FSEQ(section 5.0) function.

Definition: A "dwell" is defined as the time period during which a fixation or series of contiguous fixations remain within an Area of Interest(AOI) as defined by the AOI(section 4.0) function.

The dwell data output is comprised of a sequential list of "dwells", a summary of dwell activity in each AOI, a Transitional Matrix, a Conditional Probability Matrix, a Joint Probability Matrix, and Histogram data that can be plotted in Excel.

6.2 Creating a Dwell File

To create a dwell file:

1. Select the Dwell pull down menu.

2. Choose Make new Dwell file.

3. Once the Dwell Properties menu pops up, review the listed properties:

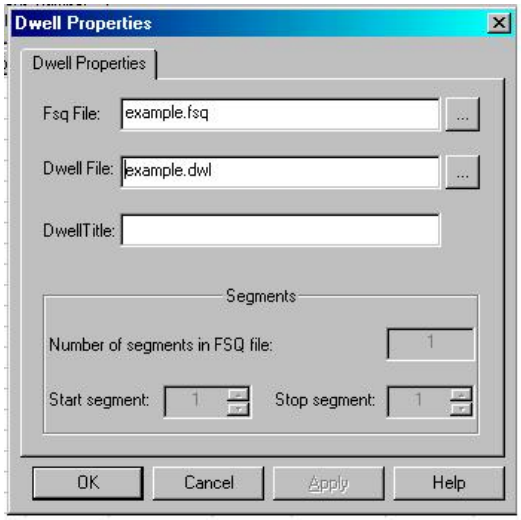
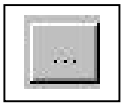


Figure 16

   - **Fsq File:** Browse to the desired Fseq file. If an Fseq file is currently open this will be the default file. This is the input file.
     NOTE: to open a Windows browser left click the icon on the right. of the text box



   - **Dwell Title:** Any information typed here will show in the file header.

   - **Dwell File:** select a name for the output file or keep the default name. The default name will be the same as the selected Fseq file.

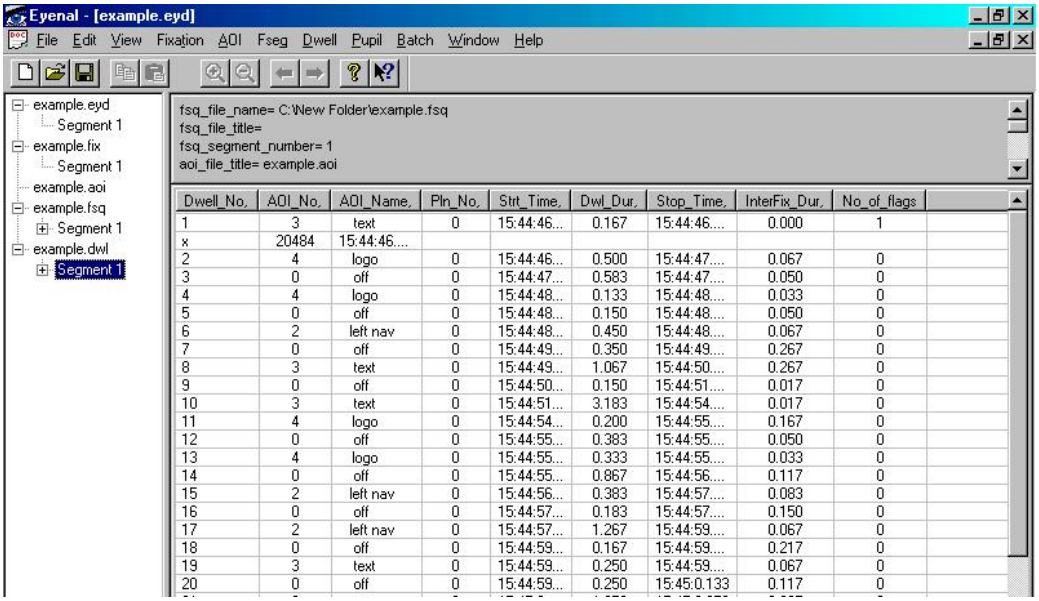
   - **Segments:** If desired select a start and stop point based on the input file segments.

4. **Click "OK"**

6.3 Dwell Sequence List

Once "OK" is selected the program lists the following information for each "dwell" sequence:

1. **Dwell No:** Dwell number
2. **AOI No./Name:** Area of Interest (AOI) number, label, and scene plane number (scene plane numbers only apply for EYE-HEAD data files) that contained the dwell.
3. **Start Time:** Dwell start time listed in hours, minutes, and seconds (HH:MM:SS.SSS).
4. **Dwl Dur:** Dwell duration in seconds. This is the sum of all the Fixation duration's that make up the dwell.
5. **Stop time:** Dwell stop time listed in hours, minutes, and seconds (HH:MM:SS.SSS).
6. **InterFix Dur:** Inter-fixation length in seconds for each dwell shift between two AOI's.
7. **No of flags:**



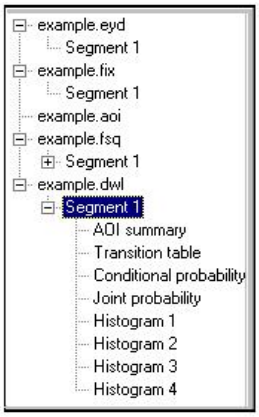
Dwell_No.	AOI_No.	AOI_Name.	Pln_No.	Strt_Time.	Dwl_Dur.	Stop_Time.	InterFix_Dur.	No_of_flags
1	3	text	0	15:44:46...	0.167	15:44:46....	0.000	1
x	20484	15:44:46....						
2	4	logo	0	15:44:46...	0.500	15:44:47....	0.067	0
3	0	off	0	15:44:47...	0.583	15:44:47....	0.050	0
4	4	logo	0	15:44:48...	0.133	15:44:48....	0.033	0
5	0	off	0	15:44:48...	0.150	15:44:48....	0.050	0
6	2	left nav	0	15:44:48...	0.450	15:44:48....	0.067	0
7	0	off	0	15:44:49...	0.350	15:44:49....	0.267	0
8	3	text	0	15:44:49...	1.067	15:44:50....	0.267	0
9	0	off	0	15:44:50...	0.150	15:44:51....	0.017	0
10	3	text	0	15:44:51...	3.183	15:44:54....	0.017	0
11	4	logo	0	15:44:54...	0.200	15:44:55....	0.167	0
12	0	off	0	15:44:55...	0.383	15:44:55....	0.050	0
13	4	logo	0	15:44:55...	0.333	15:44:55....	0.033	0
14	0	off	0	15:44:55...	0.867	15:44:56....	0.117	0
15	2	left nav	0	15:44:56...	0.383	15:44:57....	0.083	0
16	0	off	0	15:44:57...	0.183	15:44:57....	0.150	0
17	2	left nav	0	15:44:57...	1.267	15:44:59....	0.067	0
18	0	off	0	15:44:59...	0.167	15:44:59....	0.217	0
19	3	text	0	15:44:59...	0.250	15:44:59....	0.067	0
20	0	off	0	15:44:59...	0.250	15:45:0.133	0.117	0

Figure 17

Navigation:

Left click on the + sign to extend the Dwell file tree.

Left click on any of the subsequent files to view contents



6.3.1 Dwell Sequence Summary

The program lists the following summary information for each "dwell" FSQ data segment processed and for each defined Area of Interest (AOI). To view the Dwell Sequence Summary left click "AOI Summary" in the Dwell file tree.

- Area of Interest (AOI) area number, name, and scene plane number. Area number zero (0) always represents an undefined dwell area off the scene.
- The total number of Dwells occurring in the Area of Interest.
- The mean (average) Dwell duration and standard deviation in seconds.
- The median dwell duration in seconds.
- The skew value (difference between the mean and median duration) for the Area of Interest.

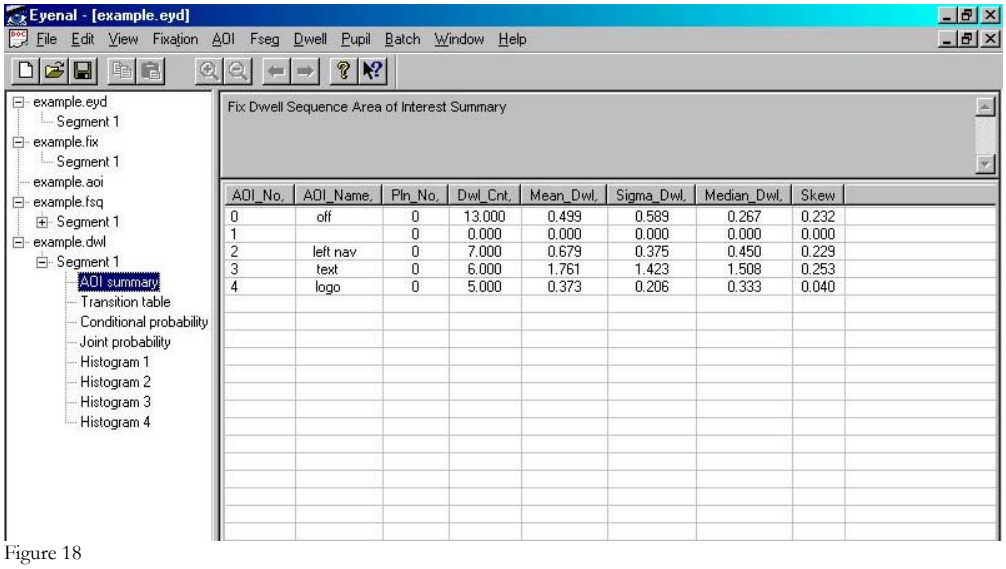


Figure 18

6.4 Dwell Transition Table

The Transition Table is a matrix representing the actual amount of transitional activity between Areas of Interest(AOI's). A transition from **i** to **j** is the change from a dwell period in Area **i** to a new dwell period in Area **j**.
To view the Dwell Transition Table left click on "Transition table" in the Dwell file tree.

> **Reading the Transition Table:** GO TO Section 5.3.4 "Reading the Transition Table" and Figure 11 for a sample transition table.

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6.4.1 Dwell Conditional Probability Table

Definition: Conditional probability is the likelihood that given a dwell on one specific area, the next dwell will be on another specific area.

$$Pc(i/j) = \frac{\text{No. of dwell transitions from Ai to Aj}}{\text{No. of dwells on Ai}}$$

Reading the Conditional Probability Table:
This table reads the same way as the transition table except that it is a matrix representing the conditional probability of transitional activity between Areas of Interest(AOI's).
GO TO: section 5.3.4 for information on reading a transition table.

6.4.2 Dwell Joint Probability Table

Definition: Joint probability is the relative likelihood (or relative frequency) of a transition between two particular areas as compared to transitions between other pairs of areas.

$$Pj(i,j) = \frac{\text{No. of fixation(or dwell) transitions from Ai to Aj}}{\text{Total number of transition pairs}}$$

Reading the Joint Probability Table:
This table reads the same way as the transition table except that it is a matrix representing the joint probability of transitional activity between Areas of Interest(AOI's).
GO TO: section 5.3.4 for information on reading a Transition table.

6.4.3 Dwell Histogram

The Dwell function will produce histogram data for each Area of Interest included in the file.

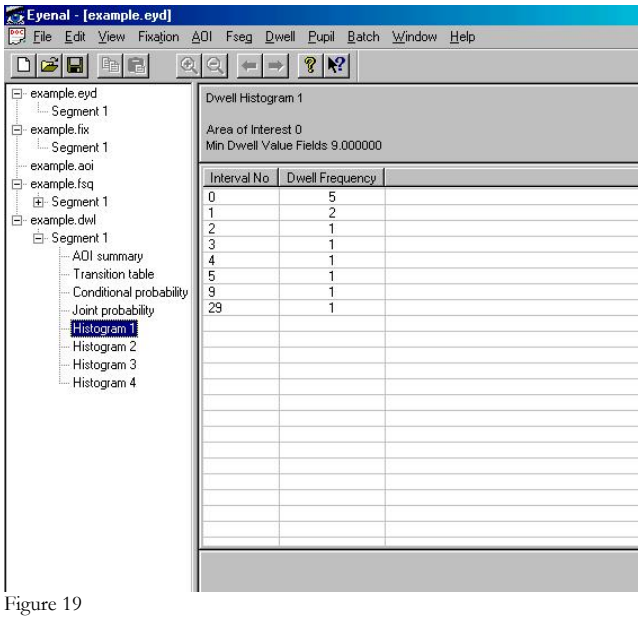

Figure 19

7. Pupil Statistics

7.1 Purpose and Application

The Pupil Function will compute various statistics based on pupil diameter for specified amounts of time on a data file. The pupil data output is comprised of a sequential list of pupil diameters for each data field, pupil average, pupil median, pupil variance, standard deviation and blink frequency.

7.2 Making a Pupil (pdf) file.

1. Select "Make new pupil diameter analysis file" from the Pupil pull down menu.

2. Once the "… Properties" window pops up, review the listed properties:

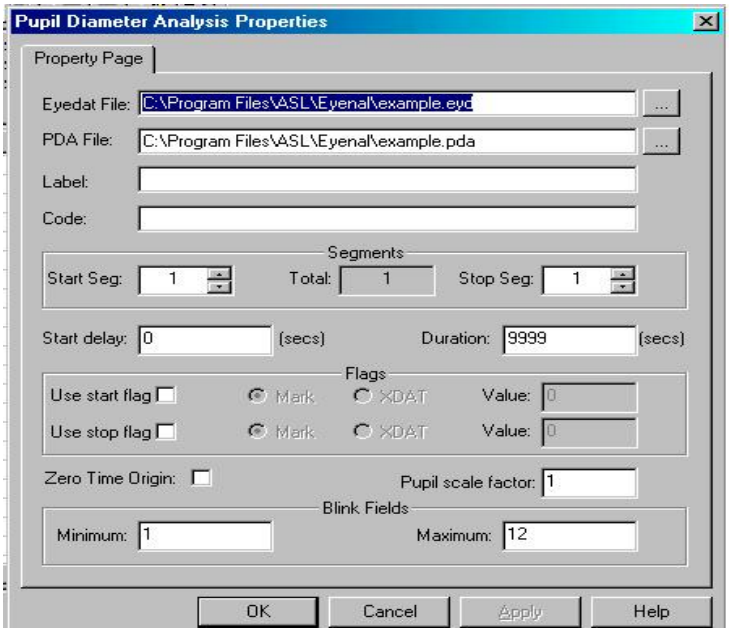

figure 20

   a. **Eyedat File:** this is the source file**.**

   b. **PDA File:** this will be the output file name. If desired change the output file name or keep the default name.

   c. **Label:** Information typed here shows up in the file header

   d. **Code:** Information typed here shows up in the file header

   e. **Segments:** A PDA file can be made with only a portion of the source file (if the source file has +1 segments). A start and stop point can also be designated by Eyedat file segment.

   f. **Start Delay:** It is also possible to delay the analysis start point in seconds. When using a start delay one can also specify a **Duration** of the file (seconds) to be analyzed.

      e.g. If a file was 10 minutes long; a start delay of 60 seconds and a duration of 60 seconds would yield information from minute 2 of that file.

   g. **Use start flag** Mark or X-DAT values may be used as flags to trigger the beginning of fixation calculations. Check this box to use a start flag then specify the appropriate flag in one of the two boxes to the right.. **NOTE:** For more information on Marks and X-DAT refer to the ASL Model 501/504 user manual.

   h. **Use stop flag** Mark or X-DAT values may be used as flags to trigger the end of fixation calculations. Check this box to use a stop flag then specify the appropriate flag in one of the two

boxes to the right. **NOTE:** For more information on Marks and X-DAT refer to the ASL Model 501/504 user manual.

i. Zero Time Origin: If this box is checked, the time value at the start of the segment processed will be set to 00:00:00.000. This option only effects the output file.

j. Pupil Scale factor: Pupil scale factor Pupil diameter may be scaled to meaningful units such as millimeters. To compute a scale factor for pupil diameter values displayed by or recorded on the Interface program :

4. First place the Model Eye at the same eye to camera distance present during experimental conditions.
5. Second obtain proper discrimination on the model pupil.
6. Third note the pupil diameter value on the interface screen digital display window ("Pupil Diameter: *nnn*").

To compute a scale factor, divide the recorded value by **3.96** (the diameter of the Model Eye pupil). Convert displayed or recorded pupil diameter values to millimeters by applying this scale factor (value in millimeters = scale factor * recorded value). See the 501.504 Manual section "Using the Model Eye" for more information.

k. Blink Fields: If the number of consecutive lost data fields (pupil diameter =0) in an EYEDAT data sample is between the defined Blink Minimum and Blink Maximum number of fields than the losses are considered a blink. A number of consecutive lost fields less than the minimum or greater than the maximum are considered losses.

The Blink frequency result for a EYEDAT data sample selection is calculated as:

$$\text{blink frequency} = \frac{\text{number of blinks in data sample}}{\text{sample duration in seconds}}$$

3. Click OK

7.3 Pupil Diameter Sequence List

Once a **pda** file is made the program will display a list of each data field selected and the corresponding pupil diameter. (see figure 20)

7.3.1 Pupil Data Summary List

The Pupil Diameter Summary lists the following statistics based on the specified parameters. The data summary includes the number of samples, mean, median, and standard deviation of pupil diameter values for the selected data sample. The Blink Frequency calculation is also included in the data summary.

Note: Pupil diameter values of zero (loss) are not included in calculations of the statistical values listed above.

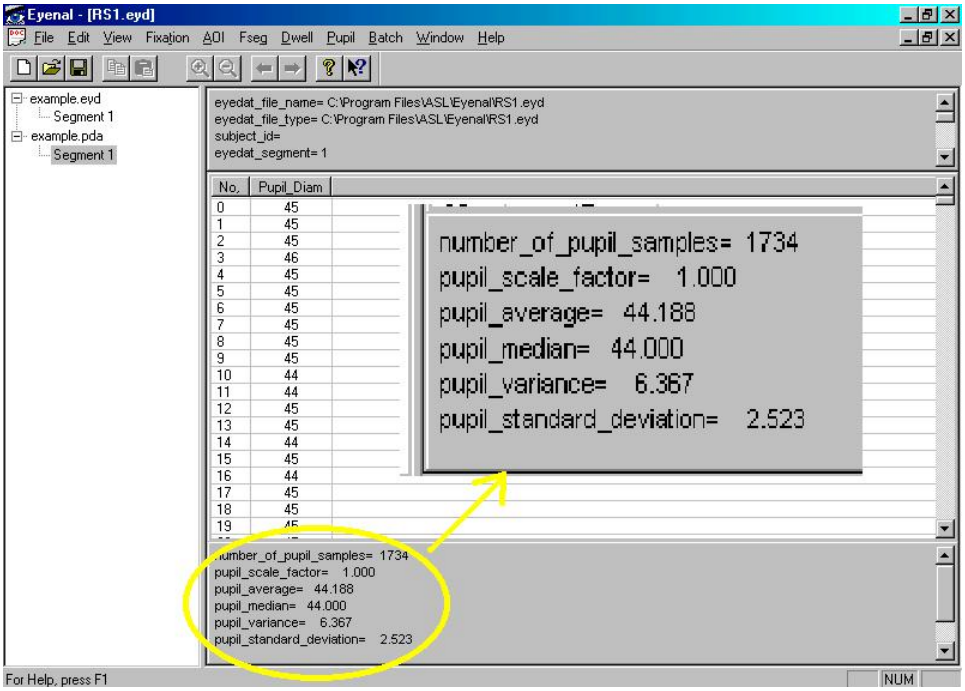

Figure 21

8. Batch Function

8.1 Purpose and Application

The Batch function allows the user to create Fixation, Fixation sequence, and Dwell files for any number of selected EHD or EYD files in a given directory.

8.2 Using the Batch Function

1. Select the Batch pull down menu.
2. Select the desired output file format(Fixation, Fix sequence, or Dwell) for Batch.
3. If the desired output file format was: Fixation file GO TO section 8.2.1
   Fix Sequence file GO TO section 8.2.2
   Dwell file GO TO section 8.2.3

8.2.1 Batch Fixation Files

1. Once the Batch Properties menu pops up :
2. Select the desired Source directory
3. Select the desired Output directory
4. All **.eyd** and **.ehd** files located in the source directory will be listed below.
5. Select desired source files:
   To **include** a file for Batch, leave a red check mark next to the file name
   To **exclude** A File from Batch, double click on the "red check mark" to remove it.
6. To add or change the following items for individual output files :
   A) Double click on the desired output file name
   B) Change or adjust desired field in the resulting Properties pop up window and click APPLY. For further explanation of the listed items GO TO section 3.2

   Output File Name
   Title
   Code
   Start Point (by Segment or delay in secs)
   Stop Point (by segment or duration in secs)

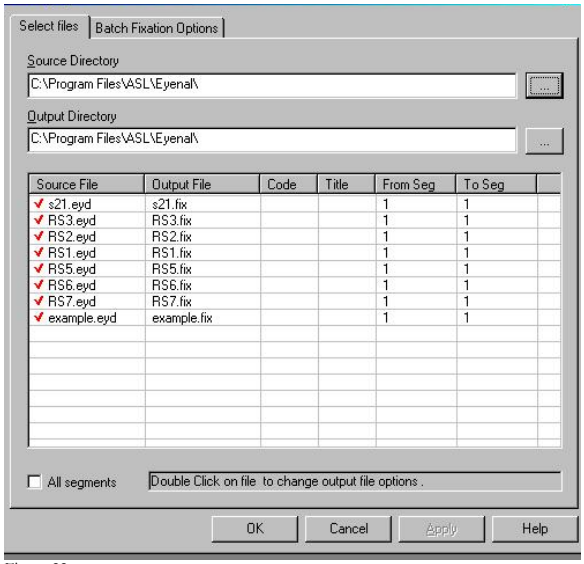

Figure 22

7. To set Fixation Criteria for the selected files left click the tab labeled ***Batch Fixation Options*** at the top of the Batch properties pop up menu.
   For more in formation on Fixation Criteria GO TO section 3.2.1

8. Click OK
   NOTE: the Batch function will now create fixation files for each selected source file based on the specified parameters and criteria. These files will be located in the specified source directory.

8.2.2 Batch Fixation Sequence Files

1. Select "Batch Fix Sequence" from the Batch pull down menu
2. Select the desired AOI file from the Windows browser
3. Once the Batch Properties menu pops up
4. Select the desired Source directory
5. Select the desired Output directory
6. All **.eyd** and **.ehd** files located in the source directory will be listed below.
7. Select desired source files:
   To **include** a file for Batch, leave a red check mark next to the file name
   To **exclude** A File from Batch, double click on the "red check mark" to remove it.
8. To add or change the below listed items for individual output files :
   A) Double click on the desired output file name
   B) Change or adjust desired field in the resulting Properties pop up window and click APPLY. For further explanation of the listed items GO TO section 5.2

   Output File Name
   Title
   Code
   Start Point (by Segment or delay in secs)
   Stop Point (by segment or duration in secs)

9. Click OK
   NOTE: the Batch function will now create Fixation Sequence files for each selected source file based on the specified parameters. These files will be located in the specified source directory.

8.2.3 Batch Dwell Files

1. Select "Batch Dwell" from the Batch pull down menu.
2. Once the Batch Properties menu pops up
3. Select the desired Source directory
4. Select the desired Output directory
5. All **.fsq** files located in the source directory will be listed below.
6. Select desired source files:
   To **include** a file for Batch, leave a red check mark next to the file name
   To **exclude** A File from Batch, double click on the "red check mark" to remove it.

7. To add or change the below listed items for individual output files :
   A) Double click on the desired output file name
   B) Change or adjust desired field in the resulting Properties pop up window and click APPLY. For further explanation of the listed items GO TO section 6.3

   Output File Name
   Title
   Code
   Start Point (by Segment or delay in secs)
   Stop Point (by segment or duration in secs)

8. Click OK
   NOTE: the Batch function will now create Dwell files for each selected source file based on the specified parameters. These files will be located in the specified source directory.